Original Article

Comparative Study of Intrapartum Cardiotocography and Umbilical Cord Blood pH at Birth in Terms of Perinatal Outcome

Priyanka Rani[1], Taanisha Manhas[1], Meenakshi Johari[2], Kanchan Dalmia[3], Ranjana Gupta[4], Savita Gupta[5], Kush Pratap Singh[1]

[1]Junior Resident, Department of Obstetrics and Gynaecology, Rohilkhand Medical College & Hospital, Bareilly, UP, India. [2]Associate Professor, Department of Obstetrics and Gynaecology, Rohilkhand Medical College & Hospital, Bareilly, UP, India. [3]Professor and Head, Department of Obstetrics and Gynaecology, Rohilkhand Medical College & Hospital, Bareilly, UP, India. [4]Professor, Department of Obstetrics and Gynaecology, Rohilkhand Medical College & Hospital, Bareilly, UP, India. [5]Assistant Professor, Department of Obstetrics and Gynaecology, Rohilkhand Medical College & Hospital, Bareilly, UP, India

Abstract

Background: CTG is highly predictive of fetal well-being and has been used for over 50 years to monitor the fetus. But, CTG is subject to interpretation and largely relies on the guidelines based on imprecise and fixed FHR patterns. The objective is to assess the relationship of CTG with perinatal outcome and umbilical cord blood pH. **Material and Methods:** This was a prospective cross-sectional study carried out on 185 women at 37 weeks of gestation in the first or second stage of labour in the Department of Obstetrics and Gynaecology, Rohilkhand Medical College and Hospital, Bareilly. The study was conducted over 1 year, from Aug 23 to July 24. **Results:** Of 185 neonates, the majority (161) had a normal umbilical cord pH (>7.2), and 24 (12.97%) had a low pH (<7.2), which is a sign of fetal acidosis and a possible perinatal crisis. At 1 minute, 67.0% of the neonates had improved to 96.2% at 5 minutes, indicating effective neonatal resuscitation and care. Categories II and III abnormal CTG patterns were strongly associated with LSCS, decreased umbilical cord blood pH, and NICU hospitalization, reinforcing their predictive value. **Conclusion:** CTG is an effective device in the real-time monitoring of the fetus, and the abnormal trends significantly predict unfavorable neonatal outcomes. The umbilical cord blood pH and APGAR score have been shown to assess the neonate's health and guide postnatal care effectively.

Keywords: Intrapartum cardiotocography, Umbilical cord blood pH, perinatal outcome.

Received: 23 November 2025 **Revised: 10 December 2025** **Accepted: 31 December 2025** **Published: 23 January 2026**

Introduction

Maternal and neonatal health is always a significant issue of concern in all parts of the world, particularly in developing countries such as India. Low access to high-quality medical care leads to high levels of maternal and neonatal mortality in these countries, and, therefore, a multisided approach to this issue is necessary, especially when it comes to labour, a life-threatening period for the mother and child's well-being. Labour is a stressful experience for the fetus, and in case complications occur, it can lead to life-threatening outcomes unless it is noticed and acted upon promptly.[1]

Though with each contraction, the fetus endures intermittent, hypoxia induced by compressing of the uterine vessels, even though healthy fetuses usually have no problems in adapting to such disruptions, fetuses that have inadequate reserves tend to develop more severe complications such as fetal acidosis, hypoxic-ischemic encephalopathy (HIE), seizures, and in some cases, cerebral palsy. Thertermfetal distress is recommended as a replacement for the term fetal distress to describe the serious complications caused by the failure of the fetus to cope with the stress of labour, which is why "non-reassuring fetal status" is proposed to take its place instead. This nomenclature reflects the significance of fetal compromise early detection so that early interventions can take place.[1]

CTG is defined as an ongoing FHR recording obtained graphically using two transducers: one a co-probe, the other a FHR trace placed on the abdomen, recorded for up to 20 minutes when the patient is in labour.

Besides, CTG, the pH of umbilical cord blood is another vital indicator of infant well-being. It helps identify hypoxia and acidosis in the fetus, both of which have adverse consequences. Umbilical cord blood pH, which is measured right after birth, represents a direct measure of the acid-base balance of fetuses. Newborns have a normal pH of about 7.2. Acidosis, or a pH below 7.2, is divided into two types: respiratory acidosis and metabolic acidosis. Brief, reversible umbilical cord compression causes respiratory acidosis, whereas prolonged oxygen deprivation causes a more severe metabolic acidosis.[2]

pHofcordblood is a reliable, objective indicator of neonatal wellbeing, especially in establishing whether the fetus was compromised by hypoxia or acidosis during labour; however,

Address for correspondence: Dr. Taanisha Manhas, Postgraduate Resident, Department of Obstetrics and Gynaecology, Rohilkhand Medical College & Hospital, Bareilly, UP, India.
E-mail: taanishamanhas@gmail.com

DOI:
10.21276/amit.2026.v13.i1.305

How to cite this article: Rani P, Manhas T, Johari M, Dalmia K, Gupta R, Gupta S, Singh KP. Comparative Study of Intrapartum Cardiotocography and Umbilical Cord Blood pH at Birth in Terms of Perinatal Outcome. Acta Med Int. 2026;13(1):107-112.

its usefulness is limited to the post-delivery phase and hence cannot provide real-time feedback during labour. To fill this gap, the ability to monitor CTG in real-time prevents any ambiguity as to whether the fetus has been affected by hypoxia or acidosis in utero and therefore provides an accurate measure of the fetal well-being.

The occurrence of hypoxia and acidosis due to labor intrapartum asphyxia may result in adverse fetal outcome. Hence, a reliable route to diagnosing acidosis may help predict adverse events in neonates, enabling a timely response. CTGismostwidely used method to continue fetal monitoring during labour has been currently used. Numerous studies have been made, but its effectiveness as an individual tool in detecting suffering in the fetus remains doubtful. Our research aimed to determine the reliability of CTG as a non-invasive technique of volumtarily forecasting the fetal acidosis through the comparison of the CTG with the umbilical cord pH upon birth to deliver them within the window of opportunity before the situation takes a grave turn and the neurological damages occur.

Materials and Methods

In this prospective cross-sectional study, 185 women at 37 weeks' gestation in the first or second stage of labour were studied in the Department of Obstetrics and Gynaecology, Rohilkhand Medical College and Hospital, Bareilly. The period spent studying lasted 1 year, from August 23 to July 24.

Sample Size: The sample size can be calculated in the following way:

p=Anticipatedproportion7 q=100 – p

L=absolute error (5%) N= 4pq/L2

=4x 86.6 x 13.4 /25

Using this formula, the sample size came out to be -185.

Inclusion Criteria:

1. Singleton pregnancy
2. Term(37weeks-42weeks) and cephalic
3. Spontaneous onset of labor
4. Informed consent

Exclusion Criteria:

1. Preterm premature rupture of membrane (PPROM) and Premature rupture of membrane (PROM).
2. Oligohydramnios or polyhydramnios
3. Abnormal Doppler study
4. Antepartum hemorrhage
5. Malpresentation
6. Congenital anomalies
7. Female with comorbidities like HTN, DM, etc.

Methodology: Following institutional ethics committee approval and the patient's written informed consent, a detailed history of age, parity, past pregnancies, and any clinical conditions was obtained. To compute the gestational age, LMP (last menstrual period) was requested; if not known, the earliest USG was used. To obtain baseline data on all participants, a general history was administered.

Intrapartum fetal monitoring was done with a cardiotocograph with transducers attached, which detects fetal heart as well as uterine activity. Based on patterns of FHR and other variables, CTG tracings were classified according to the NICHD classification system as Category I (normal) and Category II (indeterminate or abnormal), respectively.

This is done as soon as delivery of the baby is complete, but before delivery of the placenta, the umbilical cord is doubly clamped with a Kocher clamp and cut. The cord blood was collected in our institute using a pre-heparinised syringe and 2-3mlof the blood. Fetal acidosis was measured using the cord blood pH of the arteries. ApH less than 7.20 or greater than 12mmol/Lbase deficit was the test of fetal acidosis.

Apgarscoringsystem Dr.Virginia Apgar introduced this system in 1953, having five components, each with points of 02, and the Apgar score was calculated at 1 minute and 5 minutes after birth. A total Apgar score of 10 indicates a healthy baby; a score of 7 at 1 and 5 minutes indicates a moderately depressed baby; and a score of 5 at 1 and 5 minutes indicates a severely depressed baby.

The primary perinatal outcomes assessed included:

- Apgarscoresat1and5minutes.
- pH values of umbilical cord blood.

To NICU admission, as required.

Statistical Analysis: Data entry and coding were performed in Microsoft Excel. Data were analyzed using SPSS version 23.0 on Windows. Depending on the type and distribution of data, a corresponding statistical test was applied, and $p < 0.05$ will be taken as significant.

Results

Most of the participants (50.8%) were within the 21-25 years age group, then 33.0% within the 26-30 years age group, and a smaller proportion of the combined age group within the 36-40 years (3.2%). The mean age of the study population was 25.52, which was near the young age bracket, and the standard deviation of the age was 4.14 years. These results indicate that the study sample was composed mostly of females in their prime childbearing years, consistent with the age distribution of birth mothers in a clinical population, as the age of mothers may affect perinatal outcomes and the quality of life of the child.

The majority of the participants (35.7% and 27.0% respectively) came out as lower middleclass and upper lowerclass, respectively, with the upper middleclass (22.2%) coming in third place. A smaller proportion of the population was in both the lower (9.7%) and upper (5.4%) socio-economic groups. Such a distribution implies that the study has mostly included representatives of middle- and lower-socioeconomic groups, which can be explained by the fact that this group reflects the demographic profile of patients who frequently use healthcare services in the area.

The average height of the sample used was also found to be 156.7 cm, and the SD was 7.71, which spans the height range of 145.0cm to 170.0cm. The average weight of the sample size was also found to be 70.4kg with an SD of 11.6kg.

The proportion of women with the maximum number was 71.4 per cent. (n=132) with 28.6 per cent. (n=53) as primigravida and multigravida, respectively. This distribution implies that the study was predominantly carried out among women with

antecedent obstetric experience, which is critical, as obstetric experience may greatly affect perinatal outcomes. The women with more than one pregnancy are usually believed to possess varied dynamics and risks of labour than primigravida, which could influence intrapartum cardiotocography and deoxygenated blood pH in the arteries of the umbilical cord.

Sixty-three point eight percent (63.8%; n=118) were in the rural areas, with 36.2% (n=67) residing in the urban areas; this indicates that the majority of the sample population in the healthcare environment was based in rural regions, serving semi-urban and rural populations.

Table 1: Distribution of pregnant women according to POG (weeks)

POG (in weeks)	Frequency	Percentage (%)
37	31	16.8%
38	33	17.8%
39	26	14.1%
40	32	17.3%
41	34	18.4%
42	29	15.7%
POG (in weeks), Mean ± SD:	39.50 ± 1.71	

The highest POG of 41 weeks comprised 18.4% (n=34) of the participants; the next highest was 38 weeks (17.8%), 40 weeks (17.3%), and 37 weeks (16.8%). There were small numbers of people at 42 weeks (15.7, n=29) and 39 weeks (14.1, n=26). The average POG was 39.50 weeks and overall standard deviation (SD) =1.71 weeks, which implies that the majority of the participants gave birth to full-term babies or near term babies. This distribution is essential since the POG at birth may greatly affect fetal outcomes, such as the CTG pattern, and cord blood pH.

Table 2: Distribution of CTG Category of Subjects

CTG Category	Frequency	Percentage (%)
I	112	60.5%
II	55	29.7%
III	18	9.7%
Total	185	100%

Most of the participants, 60.5% (n=112), fell into category I, which indicates normal FHR patterns and reassuring fetal status. An indeterminate or equivocal CTG result of category II was found in 29.7% of subjects (n=55). A smaller proportion (9.7%; n=18) fell into Category III, suggesting that although the majority showed normal CTG results, a small subset showed various levels of concern necessitating clinical follow-up.

Most of the respondents, 67.0% (n=124), gave birth through term vaginal delivery (TVD), and the remaining 33.0% of the participants (n=61) gave birth using lower segment cesarean section (LSCS). This finding is representative of the increased rate of vaginal delivery among the study population since it aims to ensure increased use of natural delivery where it is clinically viable. Nevertheless, the high percentage of LSCS demonstrates its need in situations when maternal or fetal indications are indicated, like abnormal CTG results or obstructive complications.

Table 3: Distribution according to Indication for LSCS

Indication for LSCS	Number	Percentage (%)
Fetal Distress	24	39.3
Meconium-stained liquor	18	29.5
Prolonged labour	11	18.0
CPD	8	13.1
Total	61	100.0

The most frequent was fetal distress, which caused 39.3% (n=24) of the LSCS cases, benign meconium-stained liquid in 29.5% (n=18), protracted labour in 18.0% (n=11), and cephalopelvic disproportion (CPD) in 13.1% (n=8). The results are significant because fetal monitoring and clinical assessment are important for identifying the mode of delivery. The most important cause is fetal distress, which stresses the need to introduce timely intrapartum interventions, which are usually informed by abnormal CTG patterns. In the same manner, meconium-stained liquor and prolonged labor are indicative of the necessity to have close oversight to avoid negative outcomes.

Table 4:1-minAPGARscoreoftheneonates

APGAR at 1 minute	Frequency	Percentage (%)
≤ 7	61	33.0
> 7	124	67.0
Total	185	100.0

Apgar scores of most neonates (67.0%, n=124) were above 7, indicating good initial adaptation to extra uterine life.

Nonetheless, 33.0% (n=61) had an APGAR score of 7 or less, or mild to moderate perinatal stress or compromise. This distribution underscores the importance of early neonatal assessment in the detection of an infant who would need urgent resuscitative interventions.

Table 5: 5 min APGAR score of the neonates

APGAR at 5 minutes	Frequency	Percentage (%)
≤ 7	7	3.8
> 7	178	96.2
Total	185	100.0

The number of babies with an APGAR score above 7 (n=178, 96.2) was very high, which meant that the neonatal status of the babies was adapting properly and recovering after delivery. The percentage of neonates with an APGAR score of 7 or less was only 3.8% (n=7), indicating that perinatal stress still had an effect or that they still needed neonatal care. The significant difference in APGAR scores at 1 and 5 minutes is an indicator of the efficacy of immediate postnatal interventions in addressing neonatal distress.

Most neonates (87.03%, n=161) had a pH above 7.2, indicating normal acid-base status and effective fetal oxygenation. Others with fetal acidosis, which could relate to intrapartum hypoxia or other neonatal stress factors, comprised 12.97%(n=24). Umbilical cord blood pH is an important parameter that reflects the metabolic status at birth and thus serves as a strong predictor of intrapartum well-being.

Most neonates (86.5 percent, n=160) did not require NICU admission, suggesting that, in most cases, neonatal outcomes were favorable due to the absence of neonatal complications or the need for sophisticated care. The NICU admission rate is relatively low, which speaks to the effectiveness of intrapartum monitoring and timely obstetric interventions in reducing adverse outcomes.

Most of the neonates (86.5%; n=160) were delivered healthy, suggesting favourable perinatal conditions and successful handling of labour and delivery. However, 4.3%(n=8) of persons were born with birth asphyxia, 3.8% (n=7) with neonatal sepsis, and 5.4% (n=10) with respiratory distress. These results indicate that development of neonatal difficulties is experienced in a section of cases, which is probably affected by such factors as intra-uterine occurrence, maternal wellbeing, and gestational age.

Table 6: Association of Umbilical Cord Blood pH with CTG.

	CTG								
Umbilical Cord Blood pH	I		II		III		Total		P-Value
	Number	%	Number	%	Number	%	Number	%	
<7.2	2	1.8	10	18.2	12	66.7	24	100.0	<0.001*
>7.2	110	98.2	45	81.8	6	33.3	161	100.0	
Total	112	60.5	55	29.7	18	9.7	185	100.0	

*Statistically significant.

Among the neonates with umbilical cord blood pH <7.2,66.7%(n=12) were classified under CTG Category III, and18.2%(n=10) under Category II, while only1.8%(n=2) belonged to Category I. Conversely, among neonates with cord blood pH>7.2, the majority (98.2%, n=110) were in CTG Category I, with 81.8% (n=45) in Category II, and only 33.3% (n=6) in Category III. These findings demonstrate strong ties between the presence of abnormal CTG patterns (especially the largest Category III of CTG) and reduced cord blood pH, suggesting fetal acidosis and possible perinatal acidosis. Conversely, normal CTG patterns (Category I) mostly reflect normal pH levels and indicate sufficient fetal oxygenation.

Table 7: Association of NICU Admission with APGAR score at 1 minute.

	APGARscoreat1minute						
NICU Admission	<7		>7		Total		P-Value
	Number	%	Number	%	Number	%	
No	39	63.9	121	97.6	160	100	<0.001*
Yes	22	36.1	3	2.4	25	100	
Total	61	100.0	124	100.0	185	100	

*Statistically significant.

The correlation between NICU admission and the 1-minute APGAR score was statistically significant (P<0.001). 97.6% of the samples (n=121) had an APGAR score above 7, indicating a good neonatal condition, and 63.9% (n=39) had an APGAR score below 7. On the other hand, among neonates admitted to the NICU, where the most significant subset, 88 per cent (n=22), had an APGAR score of 7 or below, the association between low APGAR scores at 1 minute and NICU admission is significant and deserves emphasis as the effect of initial neonatal compromise on the requirement of intensive care.

Table 8: Association of NICU Admission with APGAR score at 5 minutes.

	APGARscoreat5minute						
NICU Admission	<7		>7		Total		P-Value
	Number	%	Number	%	Number	%	
No	0	0.0	160	89.9	160	100.0	<0.001*
Yes	7	100.0	18	10.1	25	100.0	
Total	7	100.0	178	100.0	185	100.0	

*Statistically significant.

All (100.0%) of the amnesetics who did not require NICU admission (n=160) had a 7APGAR score, indicating full recovery and good neonatal status at 5 minutes. Conversely, all neonates with an APGAR score of 7 or less at 5 minutes of resuscitation (n=7) were admitted to the NICU, representing 100.0 percent of that cohort. Also, 10.1% (n=18) of the admitted to the NICU had an APGAR score that was higher and was still indicative of a better state, but still needed close attention. These results illustrate the crucial relationship between continuously low APGAR scores over 5 minutes, the necessity of NICU services, and the predictive utility of the score in identifying neonates with a poor prognosis.

Discussion

The mean age of our study subjects was 25.52 ± 4.14 years, with the largest percentage of 50.8% falling within the 21-25 years. However, in contrast, Ray Cand RayA7 showed a slightly higher mean age of 26.33-3.7 years, with the same percentage group predominating.

In the present study, the largest proportion of the population studied were lower-middle-income earners (35.7), a sensitive socioeconomic group in the evaluation of access to healthcare services. Sethia R et al,[1] observed that 40% of the first population study fell within the lowest two socioeconomic strata, suggesting the possibility of differences in health accessibility. These changes are important for understanding the socioeconomic consequences for health related to obstetrics.

In this case, multiparous women accounted for 71.4%, which was much higher than in other studies, such as Sethia R et al.[1] (65%) and Sharmin Z et al,[3] (58%). This may be because of cultural or geographical differences in family planning.

We found a rural majority (63.8%), which was significant in understanding the issue of access to healthcare. Sharmin Z et al,[3] gave a higher rural representation of 70 percent.

The mean in this study was 39.50 ± 1.71 weeks, and Sethia et al, one and Sharma et al, 8 gave the same mean of 39.8 ± 1.5 and 39.7 ± 1.4 weeks, respectively, indicating a trend toward full-term deliveries becoming more common in our settings.

In our analysis, the most common type of CTG was Category I, with 60.5% of the pregnant women, whereas Categories II and III were less common, with 29.7% and 9.7%, respectively. The overall pattern of CTG was a great encouragement to our cohort compared with Singh et al,[9] (2022), with 92% of all CTG tracings reassuring, compared with fewer normal tracings in the first study. OurfindingsshowedahigherrateofTVDat67.0%compairedwith33.0%for LSCS. This contrasts dramatically with Singh et al,[9] (2022), who reported an increased cesarean birth rate due to unfavorable CTG data. Our preference for vaginal delivery in our cohorts implies that prenatal care works and could reduce the number of more complicated labour situations, which further reassures the significance of the local obstetric practices.

In this case, the key suggestive indicators of LSCS were fetal distress (39.3%), MSL (29.5%), long labour (18.0%), and CPD (13.1%). This pattern of indication is evident in the results of Paikaray et al,[10] (2024), in which the presence of suspicious or pathological CTG patterns was significantly associated with operative deliveries.

Newborn APGAR scores were above seven at 1 and 5 minutes, indicating predominantly good initial postnatal conditions. It was in line with evidence by Syed et al,[11] (2020), who demonstrated a positive relationship between APGAR scores and umbilical cord pH, indicating that the management of intrapartum conditions positively influences healthy neonatal outcomes.

We have observed a strong association between reduced umbilical cord blood pH and extreme CTG classes, with 66.7% of Category III CTGs showing a pH less than 7.2 and a p-value of 0.001. This was consistent with the research by Syed et al,[11] (2020), who also reported a statistically significant association between low cord pH and poor newborn outcomes, such as increased NICU admissions. Equally, Paladugu V et al. found that pathological CTG tracings tended to improve the predictability of suggesting that the CTG reflected fetal acid-base conditions immediately after parturition.

In our study, 72.2 per cent of NICU admissions with Category III CTG were identified, with a p-value less than 0.001, indicating a very strong correlation between pathological CTG results and the need for NICU admission. This is consistent with the results of Singh et al,[9] (2022), who observed a strong correlation between CTG abnormalities and high NICU admissions. In addition, Nabiyalet al,[13] (2023) also found that the presence of an abnormal CTG tracing was predictive of fetal acidosis that commonly results in the need to support babies in the NICU by the Emergency Room.

These results showed a strong correlation between lower APGAR scores at 1 minute (below 7) and NICU admissions, with 36.1% of these cases requiring NICU care. This was in agreement with Paikaray et al,[10] who found that low combined APGAR scores are significantly correlated with poorer NICU outcomes, such as the need for an intensive care device like CPAP or mechanical ventilation, which is characteristic of the NICU.

Equally, our study indicated that all NICU admissions (100%) with an APGAR score below seven at 5 minutes were significant indicators of the importance of early neonatal

assessment in determining the need for intensive care. This is consistent with the other research done by Malin et al,[14] which has strongly determined the positive relationship between poor APGAR scores and severe neonatal morbidity and mortality, indicating that urgent medical intervention is necessary to achieve better outcomes.

Conclusion

CTG is useful for real-time fetal monitoring, and anomalous trends are a strong predictor of poor neonatal outcomes. Umbilical cord blood pH and APGAR score are effective measures of neonatal health and postnatal care. Obstetric interventions, depending on CTG results, can help mitigate neonatal complications and improve outcomes predictively. CTG Strengthening intrapartum monitoring and early intervention strategies, particularly where resources are limited, as in India.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Sethia R, Naskar A, Tripathy S, Das R. Association between intrapartum cardiotocography and umbilical cord blood pH in term pregnancies: A cross-sectional study in a tertiary care centre. Journal of Clinical and Diagnostic Research: JCDR. 2022 Feb;16(2) QC 19-QC22
2. Cunningham F, Leveno K, Bloom S, Spong CY, Dashe J. Williams obstetrics, 24e. McGraw-Hill; 2014.
3. SharminZ, BegumN, RahmanA, ParveenF, IslamK.Monitoring intrapartum fetal distress by cardiotocography and observing its relation with umbilical cord blood sampling and perinatal outcome. SchInt J ObstetGynec. 2022;5(6):294303.
4. Grivell,RosalieMetal.“Antenatalcardiotocography for fetal assessment.”The Cochrane Database of Systematic Reviews, Vol. 2015, 2015,9CD007863.12Sep.2015.
5. Olofsson, Per. “Umbilical cord pH, blood gases, and lactate at birth: normal values, interpretation, and clinical utility.”American journal of obstetrics and gynecology vol. 228, 5S (2023): S1222-S1240.doi:10.1016/j.ajog.2022.07.001
6. Gupta K, Haritwal A, Makhija B, Bhandari R.Is fetal CTG a reliable indicator of fetal distress? A prospective study on relationship between CTG suspected fetaldistressandimmediatepostpartumumbilicalcordbloodpH..JCL INMED KAZ. 2022;19(1):57-64.
7. RayC, RayA.Intrapartum cardiotocography and its correlation with umbilical cord blood pH in term pregnancies: A prospective study. Int J ReprodContraceptObstet Gynecol. 2017;6(7):2745-52
8. Sharma S, Lamba J. The correlation between intrapartum cardiotocography (CTG) and umbilical cord arterial pH in predicting perinatal outcome.IntJSci Res. 2022;11(11).
9. Singh, S.K., Kumar, R., Agarwal, A., Tyagi, A.,&Bisht, S.S.(2022). Intrapartum cardiotocographic monitoring and its correlation with neonatal outcome. Journal of Family Medicine and Primary Care, 11(11), 7398-7405. https://doi.org/10.4103/jfmpc.jfmpc_1525_22
10. Paikaray, S., Jena, S.K., Balakrishnan, D.,&Mohanty, P.K.(2024).Correlation of cardiotocography with combined APGAR scores and diagnostic performance of umbilical cord parameters in predicting low combined APGAR scores –A prospective Cohort study. European Journal of Obstetrics & Gynecology and Reproductive Biology: X, 23, 100329.
11. Syed, W., Liaqat, N., Qazi, Q., &Yasmeen, S. (2020). Relationship between immediate postpartum umbilical cord pH, fetal distress, and neonatal outcome. Pakistan Journal of Medical Sciences, 36(7), 1529-1532.
12. PaladuguV, SreedharS, ChitraR, MannavaST, SreekumarS, MangalakanthiJ. Association of CTG diagnosis of intrapartum fetal distress and immediate postpartum acidemia in foetal umbilical artery. Amrita Institute of Medical Sciences and Research Centre, Kochi, India.
13. Nabiyal G, Paul M, Sarbhai V. Correlation of Paired Umbilical Cord pH with Abnormal Cardiotocograph in Singleton Non-high-risk Term Pregnancies. J South Asian FederObstGynae 2023;15(4):389–394.
14. Malin, G. L., Morris, R. K., & Khan, K. S. (2010). Strength of association between umbilical cord pH and perinatal and long-term outcomes: Systematic review and meta-analysis. The BMJ, 340. https://doi.org/10.1136/bmj.c1471.